

CLAIMS

- 1 1. A device for performing electron-ion fragmentation reactions comprising:
 - 2 (a) a multi-electrode structure,
 - 3 (b) a generator delivering radiofrequency voltages to the multi-electrode structure to form an electric multipolar radiofrequency field,
 - 4 (c) an ion source delivering ions into the radiofrequency field, where the ions are confined in a spatially limited region by the radiofrequency field for at least some period of time,
 - 5 (d) a magnetic field source for superimposing a magnetic field on the electric radiofrequency field, and
 - 6 (e) an electron source for providing electrons with energies below approximately 20 electronvolts into said spatially limited region.
- 1 2. Device according to Claim 1 wherein the multi-electrode structure consists of straight rods.
- 1 3. Device according to Claim 2 wherein the multi-electrode structure consists of four parallel straight rods.
- 1 4. Device according to Claim 1 wherein the multi-electrode structure consists of ring and end cap electrodes.
- 1 5. Device according to Claim 4 wherein the multi-electrode structure consists of one hyperbolically shaped ring and two hyperbolically shaped end cap electrodes.
- 1 6. Device according to Claim 1 wherein the ion source delivers multiply charged ions.
- 1 7. Device according to Claim 6 wherein the ion source is an electrospray ion source.

- 1 8. Device according to Claim 1 wherein the ion source comprises an ion selector for
- 2 selecting ions with respect to their mass-to-charge ratio.

- 1 9. Device according to Claim 1 wherein an additional generator delivers AC or DC
- 2 voltages to the multi-electrode structure to eject ions of preselected mass-to-
- 3 charge ratios.

- 1 10. Device according to Claim 1 comprising a damping gas source to deliver a
- 2 damping gas to the multi-electrode structure to damp the motion of the ions and
- 3 to form a cloud of ions in the center of the multi-electrode structure.

- 1 11. Device according to Claim 1 wherein the electron source comprises an electron
- 2 emitter.

- 1 12. Device according to Claim 11 wherein the electron emitter is located within the
- 2 magnetic field in such a way that the electrons can reach locations near the
- 3 center of the multi-electrode structure by following the magnetic field lines.

- 1 13. Device according to Claim 1 wherein the electron source comprises a voltage
- 2 generator delivering an acceleration voltage for the electrons.

- 1 14. Device according to Claim 13 wherein the voltage generator comprises an
- 2 electron pulser for pulsing the electrons whereby the time of pulses may be
- 3 locked to the phase of the radiofrequency voltage.

- 1 15. Device according to Claim 1 wherein the electron source comprises a pulse laser
- 2 for generating electrons in short pulses.

- 1 16. Device according to Claim 1 wherein the magnetic field is generated by one or
- 2 more permanent magnets.

- 1 17. Device according to Claim 1 wherein the magnetic field is generated by electric
- 2 current through one or more coils.
- 1 18. A method of obtaining efficient ion-electron reactions comprising the steps of:
 - 2 (a) providing a multipolar electric radiofrequency field for storage or guidance of
 - 3 ions,
 - 4 (b) providing positive or negative ions in a spatially limited region inside the
 - 5 radiofrequency field where the ions are confined at least some period of time;
 - 6 (c) providing electrons inside said region with kinetic energies of the electrons
 - 7 below approximately 20 eV, to allow ion-electron reactions; and
 - 8 (d) providing a magnetic field inside said region sufficiently strong to confine the
 - 9 motion of said electrons in the direction perpendicular to said magnetic field.
- 1 19. The method according to Claim 18 wherein a force field assists in directing and
- 2 guiding the electrons produced outside the spatially limited region into said
- 3 region.
- 1 20. The method according to Claim 18 wherein the electrons are provided within a
- 2 small time window of a few nanoseconds, the time being locked to the phase of
- 3 the radiofrequency voltage.